The Future of Fuel and Gas in Ohio

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According to the statistics of the United States Geological Survey, the United States produced 721,000,000,000 cubic feet of natural gas in 1918. Of this amount 61,000,000,000 cubic feet were produced in Ohio and 144,000,000,000 were consumed in the State. Ohio was the second largest consumer of natural gas, but had nearly twice as many users of the gas as any other State.

As the statistics show, the State produces less than half as much natural gas as it uses, the production per well is decreasing, and in spite of the drilling of 900 new wells per year (1918) of which 600 are producers, the volume of gas is falling off. The production of gas in this State was 80,000,000,000 cubic feet in 1915. Those acquainted with the natural gas situation recognize clearly that the natural gas supply is waning and that only a very few years will be required to find it entirely inadequate to supply more than a small percentage of the State's needs for gas.

What then? Will we have to learn to get along without gas? Will electricity be used for a substitute for gas to any large extent? Or, will artificial gas be able to take the place of the previously extraordinary bountiful natural gas?

If we figure electricity to be used with twice the efficiency that gas gives and if we figure gas at $.50 per 1000 cubic feet and electricity at $.04 per kilowatt-hour, we find that fifty cents worth of natural gas is worth $6.40 worth of electricity, and coal-gas at $1.00 per 1000 cubic feet, with half the heating value of natural gas, will be worth (per 1000 cubic feet) the same as $3.24 worth of electricity. It will be seen, therefore, that except for very small uses where the total cost is negligible, electricity cannot replace gas on a cost basis.

This, then, brings artificial gas to the fore. There are many kinds of artificial gas, but only two of these can ever be used to the enormous extent which will be required to replace or supplement natural gas. The proper thing is, of course, to supplement natural gas as it gradually fails. These two artificial gases above referred to are "Coal Gas" and "Water Gas."

"Coal gas" is the name given to the complex mixture of gases which are created when coal is subjected to destructive distillation in a closed container with complete exclusion of air. The word "created" was used purposely to emphasize the fact that the gases obtained from coal do not exist in the coal as gases before the coal is heated, but they result from the chemical break-down of the complex solid organic compounds which exist in the coal as mined and which originally came from vegetation growing on the earth's surface. This vegetation has undergone slow decomposition to a limited extent through the millions of years since it grew in the pristine swamps thus resulting in the blackened, complex, new solid compounds somewhat different from those in the vegetal debris of the ancient swamps.

When these complex organic compounds in the coal are heated in the retorts or chambers used for the destructive distillation of the coal they break down or split up and we have about 200 new compounds formed. At the temperature of the oven all these new compounds are gases and pass out of the oven thru the openings made for that purpose. These compounds are nearly all compounds of carbon with hydrogen, or with hydrogen and oxygen, although a considerable number also contain nitrogen or sulphur.

All coals contain more carbon than the hydrogen, oxygen, nitrogen and sulphur can combine with under the conditions prevailing in the retort, hence this excess carbon does not get gasified but is left behind in the retort with the mineral matter (ash) that was in the original coal. This mixture of carbon with the ash that goes with it remaining in the retort is the coke of commerce, and with properly selected coals it amounts to about 1400 pounds per ton of coal, or 70%. It will be seen, therefore, that as far as weight is concerned, the coke is by far the chief product of

the manufacture of coal gas. If this coke is of metallurgical grade it is worth more than the coal from which it was made when the steel industry is active, for most of this good coke is used for smelting iron from its ores.

Now, let us return to the gas produced from the coal. As mentioned above, this gas contains about 200 compounds. Some of these compounds are solid at ordinary atmospheric temperatures, some are liquid at ordinary temperatures and a comparatively small number remain as permanent gases. Hence, when the hot gases which leave the ovens are cooled and scrubbed in towers made for the purpose the solids and liquids condense out of the gas, forming what we know as tar and a great deal of water, while the permanent gases pass on to be further scrubbed to remove two very valuable products still remaining in the gas; these are: ammonia and the benzols. The thoroughly scrubbed gas is now ready for sale, its volume is about 12,000 cubic feet per ton of coal used, its heating value is about 550 B. T. U. per cubic foot, or about half that of natural gas.

In the production then of 12,000 cubic feet of coal gas containing one-fourth of the total amount of heat units of the original one ton of coal, we have obtained as by-products:

1400 pounds of coke worth at present prices about $5.00;
14 gallons, or about 120 pounds, of tar worth about $1.00;
5 pounds of ammonia worth about $.50;
2½ gallons of benzols worth about $1.00;
12,000 cubic feet of gas.

About 350 pounds of the coke produced is used for heating the ovens, the tar is the source of the benzols, phenols, napthalenes, anthracenes, from which all the countless coal tar dyes, drugs and reagents are made, and the ammonia is by far our chief source of the many ammonia compounds used in the chemical industries and for fertilizing the fields.

The gas thus obtained from coal is the most admirable of all the artificial gases which can be made to take the place of our waning natural gas. Its composition is about as follows:

Carbon Dioxide	1.7%
Ethylene	3.0%
Carbon Monoxide	3.6%
Hydrogen	53.9%
Methane	33.0%
Nitrogen	4.5%

and its heating valu is about half that of natural gas, or approximately 583 B. T. U.s per cubic foot gross (520 net).

This process of destructive distillation of coal for the production of coal gas may be carried out primarily for coke making or gas making; if the former, the decomposition of the coal always takes place in banks of rectangular chambers made of the best grade of refractory brick, each chamber holding about 15 tons of coal, in which case the gas and tar are not quite as high grade as when made in the modern vertical retorts which are rapidly becoming prominent. The retorts do not perhaps make quite as good coke as the chambers.

It has been see from the above that there is about 1000 pounds of coke per ton of coal used which is left after the process is completed. It was also mentioned that this coke, if of proper quality, is of great value to, is in fact, necessary to, the iron and steel industry which is the material basis of our modern civilization. However, from the point of view of the domestic gas user and maker this coke is of further very great interest, for it can alsi be changed into a very useful gas. Now let us see why it should be so changed and how it can be so changed. First, why should this coke be made into gas? The State of Ohio, as mentioned in our first paragraph, uses about 144,000,000,000 cubic feet of natural gas per year. This is equal in heat units to about 288,000,000,000 cubic feet of coal gas. To make this much coal gas would require 24,000,000 tons of coal per year, or about three-fourths of the State's normal production of coal. It will be seen, therefore, that it will be well to use the coke produced in the manufacture of coal gas to make gas if it is possible to make from it a satisfactory gas. This brings us naturally to the subject of water gas.

"Water Gas." When steam is passed over coke or any form of carbon which has been previously heated to a very high temperature. The steam is decomposed chiefly according to the following reactions:

$C + H_2O = CO + H_2 - 52794$ B. T. U.

The quantity—52,794—shows that the reaction absorbs a great quantity of heat, hence the temperature of the incandescent coke will rapidly drop. If, then, the steam is shut off and air is blown thru the coke at a tremendous rate the coke can again become extremely hot in about two minutes and steam can then again be passed thru the hot coke, reacting as before. This mixture of carbon monoxide and hydrogen made by this reaction is what is called "blue water gas." It is used very extensively for industrial purposes and when enriched, for domestic purposes. One ton of coke will produce about 60,000 cubic feet of "blue water gas," hence the coke available from one ton of coal carbonized in an oven or retort during coal gas making will produce $11/20 \times 60{,}000 =$ 33,000 cubic feet of "blue water gas."

"Blue water gas" burns with an extremely high temperature flame, much hotter than the flame obtained by burning natural gas, altho its heating value is only about 300 B. T. U. gross per cubic foot compared with the 1100 of natural gas. We get, therefore, from one ton of coal when the coke is used for making "blue water gas" 12,000 cubic feet of coal gas and 33,000 cubic feet of "blue water gas," making a total of 45,000 cubic feet of gas with a heating value of a little less than 400 B. T. U. per cubic foot, or approximately one-third of the heating value per cubic foot of natural gas. In other words, the gas obtained from one ton of coal by this combined method will be equal in heating value to 15,000 cubic feet of natural gas and containing nearly three-fourths of the heat in the original coal. To make enough of this combined coal-gas-water-gas to completely replace the present supply of natural gas would require 10,000,000 tons of coal per year for Ohio. However, since this artificial gas burns more efficiently than natural gas and since its higher cost would lead to more careful use, probably 8,000,000 tons of coal per year would supply the artificial gas requirements of Ohio. Of course, if we com-

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mence to make artificial gas in considerable quantity now to supplement the natural gas supply it would result in a much slower exhaustion of the natural gas and a gradual building up of the artificial gas industry. In this way the people could be gradually educated to the use of artificial gas and its properties. It must be remembered that all artificial gas contains carbon monoxide and it is therefore poisonous if breathed.

To summarize: One ton of coal will produce 45,000 cubic feet of coal-gas-water-gas with a heating value of 400 B. T. U. per cubic foot, 120 pounds of valuable tar, five pounds of ammonia and two or three gallons of benzols. These by-products are the bases of the following great industries: the agricultural fertilizer industry, the drug industry, the dye industries and the explosive industries, with a good many associated industries. What a tremendous growth in the chemical industries will be based upon the artificial gas industry here in Ohio! Perhaps after all the waning of the natural gas will be a boon and the chemical engineer will be one of the chief beneficiaries.

But what is that grumble we hear? It appears to be Mr. Common Citizen mumbling, "But what am I going to have to pay for gas?" The answer is, the cost of the combination gas described in this article will be about $.25 per 1000 cubic feet at the gas works for gas containing about one-third as high heating value as natural gas, but more efficient per B. T. U. Added to this cost will, of course, be the distribution cost, bringing the total cost per 1000 cubic feet to the consumer *for combination coal-gas-water-gas* to about $.50. This, we think, is to be the gas of the future.

Drawing The Line

Miss Cora was taking her first trip on the train.

The conductor came through and called for the tickets. Cora readily gave up her ticket.

A few minutes later the butcher-boy coming through called, "Chewing-gum."

"Never!" cried Cora bravely. "You can take my ticket, but not my chewing-gum."—The Overhere Digest (Minneapolis).